



Nuclear Data Program at ANL

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Argonne National Laboratory



Office of Science
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Program Overview

- ❑ *Compilation and evaluation of **Nuclear Structure & Decay Data** for **ENSDF**.*
- ❑ *Compilation and evaluation of **Decay Data** for nuclei that are of interest to **various applications** (**DDEP**) and for **nuclear isomers**.*
- ❑ *Experimental **validation** and **parameter sensitivity** studies for various nuclear models used in **fast neutron** induced reactions*
- ❑ *Compilation of **charged-particle** reaction cross section data for nuclei in the mass range **A=30-50** that are of interest for astrophysical applications.*
- ❑ *Development of improved methods for **representing and propagating errors** in both experimental and derived nuclear quantities*
- ❑ *Complementary experimental activities aimed at filling gaps in the existing databases*
- ❑ *Data dissemination*

Evaluation activities

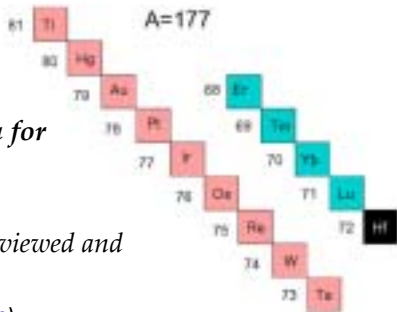
❑ Completed evaluation for all nuclei with $A=177$ for ENSDF

✓ Published in NDS v. 98 (2003) 801

❑ Evaluation of decay properties of ^{177}Lu for DDEP/Cancer Therapy Applications

✓ Submitted to the DDEP Chairman, Reviewed and

✓ Published at the DDEP electronic site
(<http://www.bnm.fr/bnm-lnhb/DDEP.htm>)



Evaluation Activities – cont.

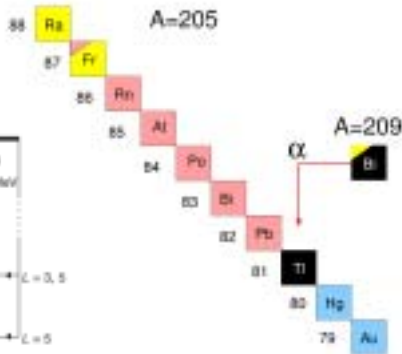
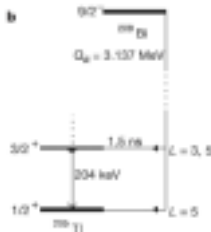
- Completed evaluation for all nuclei with $A=205$
- Data coded into ENSDF format and submitted to NNDC

letters to nature v. 422 (2003) 876

Experimental detection of α -particles from the radioactive decay of natural bismuth

Pierre de Waurel, Neil Green, Robert Smolnik, Jacques Leblond & Jean-Pierre Rosta

Journal of Experimental Physics (2003) 422 (2003) 876
DOI: 10.1038/422876a



^{209}Bi - regarded at the heaviest stable nucleus, but not anymore, $T_{1/2}=1.9 \times 10^{19} \text{ yr}$ (68% CL)

Evaluation Activities – cont.

Current Projects:

- *A=203 mass chain evaluation for ENSDF*
- *Evaluation of decay properties of $^{178m2}\text{Hf}$ and ^{177m}Lu for DDEP/Detector Efficiency Standard and potential Nuclear Energy Applications*
- *Evaluation of properties of **K-isomers** in deformed nuclei in the A~180 region - from Yb (Z=70) to Pt (Z=78) – completed the chain of **Hf (Z=72)** isotopes*
- *Survey of the status of neutron activation reaction cross sections found in various general purpose evaluated files with a view toward the implications for Homeland Security*

Experimental activities

➤ Motivation: To *fill gaps* and *improve quality* of existing databases & to find *new applications of nuclear data* in the areas of basic physics, astrophysics, nuclear energy and national security research

- ❑ *Properties of Nuclear K-Isomers in the A~180 mass region*
- ❑ *Properties of nuclei at the proton drip line*
 - *Data on ^{181}Pb , ^{181}Tl and their daughters*
 - *Data on odd-odd Au isotopes*
 - *Radiative capture in HI fusion (e.g. $^{90}\text{Zr}+^{92}\text{Mo}$, $^{90}\text{Zr}+^{89}\text{Y}$)*
- ❑ *Spectroscopy of heavy nuclei*
 - *Decay data on ^{251}Cf*
 - *Decay data on ^{253}Es*
 - *Lifetimes of very long-lived $^{245,246}\text{Cm}$ & ^{239}Pu nuclei*
- ❑ *Neutron cross section measurements in the 13-20 MeV region*

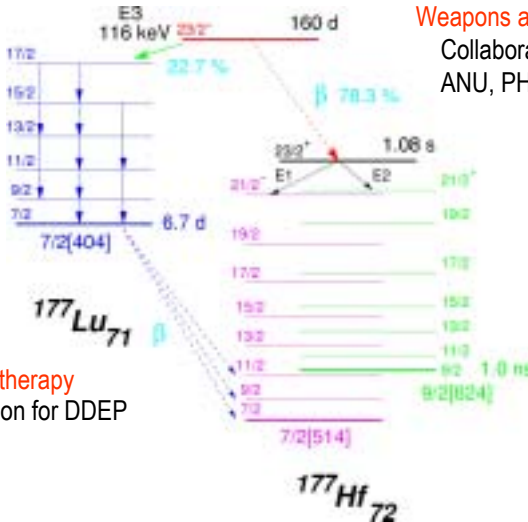
Experimental activities – cont.

□ Detector Calibration

Collaboration with UML and PHY; Production via (n,γ); Measurements at GS

□ Cancer therapy

Evaluation for DDEP



□ Nuclear Energy & Weapons applications

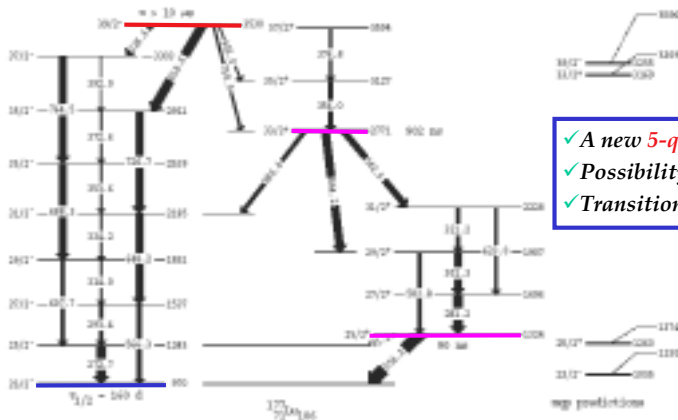
Collaboration with ANU, PHY and UML

Experimental activities – cont.

$^{176,177}\text{Lu}$: no stable beam/target combination to produce them in HI, xn

Tool: deep inelastic and multi nucleon transfer reactions

Experiment: ^{136}Xe beam on enriched ^{176}Lu target @ 6 MeV/A (~20% above the Coulomb barrier)/Pulsed beam & Gammasphere



- ✓ A new 5-qp Isomer
- ✓ Possibility of β^- branch
- ✓ Transition strength – K robustness

Submitted to *Phys. Lett. B*



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Nuclear Model Development

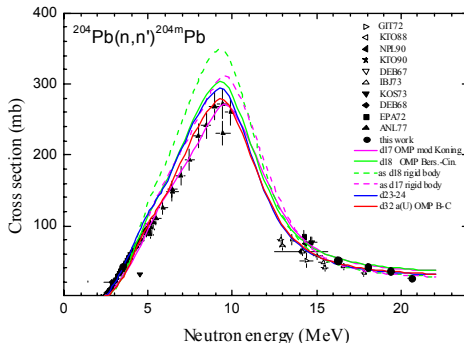
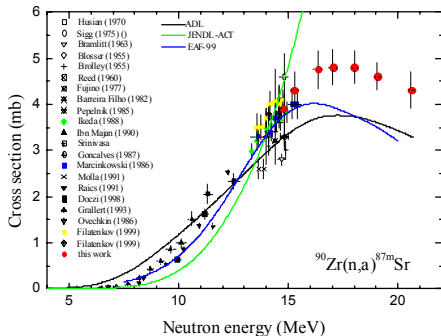
- ❑ *Argonne is participating in an international effort under the auspices of WPEC (Subgroup 19) to improve the reliability of model calculations for neutron activation cross sections.*

- ❑ *Argonne is contributing in the following areas:*
 - *Methodology development*
 - *Participation in neutron activation cross-section measurements at IRMM, Geel, Belgium.*
 - *Compilation of measured results in EXFOR format for submission to data centers.*
 - *Estimate uncertainties in evaluated results by performing parameter sensitivity analysis*

Nuclear Model Development – cont.

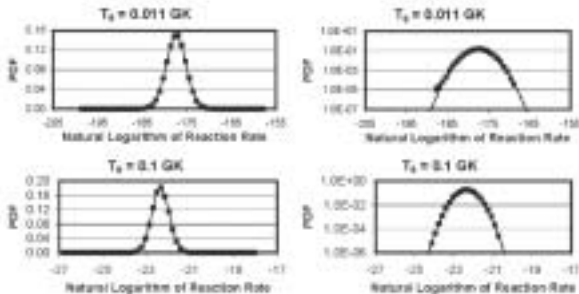
Energy range is mainly from **13-20 MeV** but also **some** work done at **lower and higher energies**

Elemental and enriched samples of **F, Na, Mg, Al, Si, P, Cl, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zr, Nb, Mo, Tc, Sn, Ba, and Pb** were used



Statistical Methods

- ❑ work is completed on *development of new procedures* for propagating errors in derived nuclear parameters



- ❑ one journal article has been published in *Nucl. Instrum. and Methods A*/ two extensive reports *ANL/NDM-154* and *ANL/NDM-156* on the Argonne Nuclear Data and Measurement Reports Web site

Nuclear Data Dissemination

NUCLEAR DATA AND MEASUREMENTS REPORTS

URL: <http://www.td.anl.gov/reports>

❑ The site contains **156 publications** produced since **July 1973** and it is devoted to:

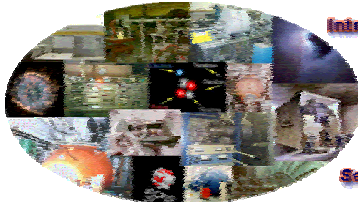
- *measured microscopic nuclear data parameters*
- *experimental techniques and facilities*
- *analysis, correlation and interpretation of nuclear data*
- *compilation and evaluation of nuclear data*

⇒ *Original reports by A.B. Smith and many others!*

Nuclear Data Dissemination-cont.

Experimental Resources for Nuclear Data Studies in the United States

www.td.anl.gov/nres



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www.td.anl.gov/NDP



These sites are current and were significantly upgraded !

